



**AFRL-RH-WP-TR-2014-0013**

## **Exploring a Dynamic Model of Trust Management Presentation**

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UNITED STATES AIR FORCE**

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# Exploring a Dynamic Model of Trust Management



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**AFOSR Program Review – Socio-Cultural Modeling/Collective Behavior  
(14-17 January 2013, Dayton, OH)**



# Air Force Relevance



- **Current influence domain (e.g., Influence Operations, Joint Targeting Cycle, Military Deception, Psychological Operations) must adapt to meet the demands of irregular warfare**
  - “A one-size-fits-all deterrence strategy will not suffice in the future joint operating environment. Such an approach assumes that we fully understand the thought processes, strategic culture, and value hierarchy and can precisely ascertain ‘red lines’ of the enemy” (Joint Operating Environment, 2010; p. 64).
- **The necessary *Precision Influence* can be realized through basic and applied research in the social sciences**

**Precision Influence represents a theoretically-driven model for behavioral influence**



# Trust = Influence



- **Developing and applying theoretical-driven and empirically supported models of trust is a key leverage point**
- **Trust is a critical factor driving human decision making and behavior**
  - Key determinant of influence (Sweeney et al., 2009)
  - ...of automated tools use (Lee & See, 2004)
  - ...of performance & positive work attitudes (Dirks & Ferrin, 2002)
  - ...of ability to adapt (Stokes, Lyons, & Schneider, 2011)

**Trust: Willingness of an individual to accept vulnerabilities from others based on positive expectations (Mayer et al., 1995)**





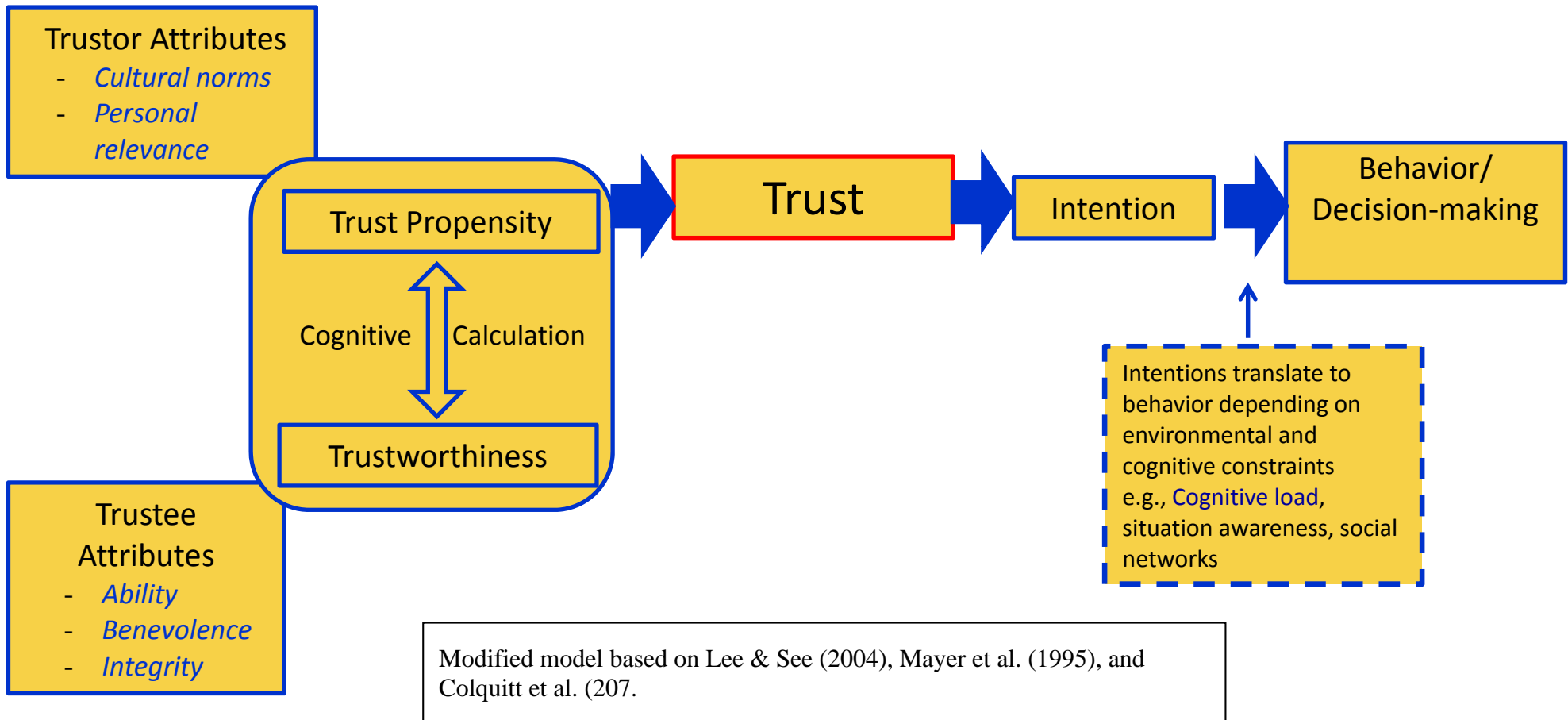
# The Trust Process

## Beliefs & Perceptions

## Attitudes

## Intention

## Behavior





# Trustworthiness: Ability, Benevolence, Integrity (ABI)



- **Parsimonious foundation of trustworthiness indicators (Mayer et al., 1995)**
  - Ability: that group of skills, competencies, and characteristics that enable a party to have influence within some specific domain.
  - Benevolence: extent to which a trustee is believed to want to do good to the trustor, aside from an egocentric profit motive.
  - Integrity: perception that the trustee adheres to a set of principles that the trustor finds acceptable.
- **To date, there have been no such studies that have empirically tested this model in different cultures.**



# Cultural Norms



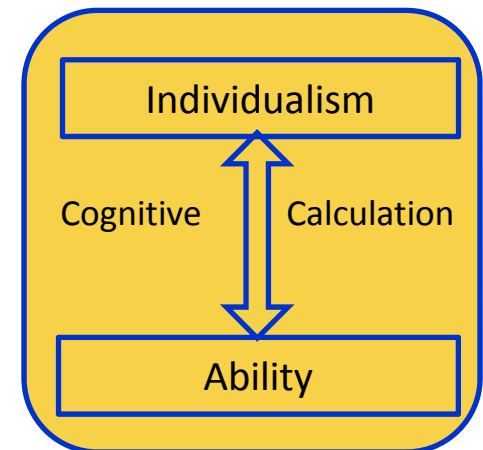
- **Foundational psychological processes are dependent, in part, on the surrounding culture within which individuals live (Fiske, Kitayama, Markus, & Nisbett, 1998)**
- **Culture has been defined according to several dimensions which are believed to influence the mechanisms through which people evaluate self and others, situations, and relationships (Fiske et al., 1998; Hofstede, 1980; Huff & Kelley, 2003)**
  - Individualism-Collectivism
  - Power Distance
  - Masculinity-Femininity
  - Uncertainty Avoidance



# Individualism-Collectivism



- **Individualism:** Characterized by strive for independent success, formulate and evaluate self based on personal goals, make independent choices, and base decisions on utility
  - Greater value for utility and personal empowerment (Fiske et al., 1998)
  - U.S. managers use more task-related appeals as influence tactic (Fu & Yukl, 2000)



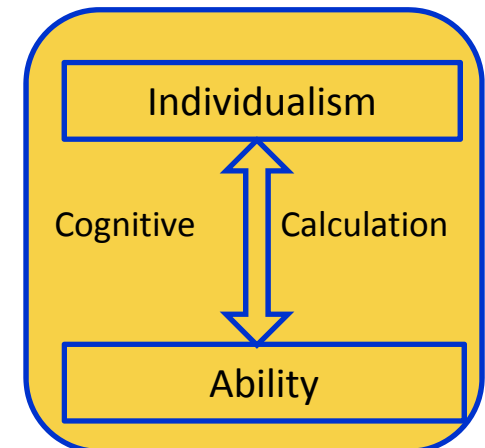
H1: Participants from an *individualistic* culture will rate trust higher when trustee *ability* is high



# Individualism- Collectivism Continued....



- **Collectivism:** characterized by value of the group above self, emphasize relationships and group goals, motivated to maintain harmony, and evaluate life based on collective needs
  - Greater value for relationships and social harmony (Fiske et al., 1998)
  - Asian managers use more relationship-oriented appeals as influence tactic (Fu & Yukl, 2000)



H1: Participants from an *collectivistic* culture will rate trust higher when trustee *benevolence* is high



# Cognitive Load (CL)



- 
- **CL represents the load that performing a particular task imposes on the cognitive system and is a key component of human information processing (Paas et al., 1994; Parasuraman et al., 2000)**
- **Increased CL leads to entrenchment of established behaviors in relation to user interfaces (Oviatt et al., 2004)**
- **The Affect Infusion Model (Forgas, 1995) suggests that during faster processing, individuals use their affective states as a short-cut to infer their evaluative reactions to a target**
  - **Similar process may occur with reliance on cultural norms as a heuristic during high CL**

**H3: CL will interact with culture such that culture effects will be strongest under high CL**



# Personal Relevance



## Relative impact of ABI indicators may vary according to the type of activity to be performed

- **Action-oriented (direct involvement)**

- Ability strongest trust predictor for situations where teams worked on a joint project (Serva et al., 2005)

H4: Participants will select applicants with higher ability in direct involvement situations (e.g., direct supervisor)

- **Judgment-oriented**

- Integrity strongest trust predictor in politically sensitive situations, e.g., performance appraisal system (Mayer & Davis, 1999; Mayer et al., 1995)

H5: Participants will select applicants with higher integrity in judgment-oriented situations (e.g., non-profit org)



# Personal Relevance Continued....



- **Relationship-oriented** (limited empirical evidence)

H6: Participants will select applicants with higher benevolence in relationship-oriented situations (e.g., co-worker)





# Method



- 
- **Design: 3 (culture) x 2 (cog. load) x 3 (ABI), mixed**
- **Target  $N = 120$  per country (U.S., Malaysia, Australia)**
  - U.S. sample classified as individualistic, Malaysian as collectivistic, consistent with previous taxonomies (Fiske et al., 1998)
  - Australian sample will serve as a comparison group for the more traditional individualistic and collectivistic nations
  - Participants recruited from local universities
- **Measures**
  - Audio recording
  - Trust Propensity (8-item; Mayer & Davis, 1999)
    - “One should be very cautious with strangers.”



# Method Continued....



- Trust (10-item; Mayer & Davis, 1999)
  - “If I had my way, I wouldn't let *this person* have any influence over issues that are important to me.”\*
- CL (manipulation check)
  - “Please rate your mental effort in the task you just performed.”



# Task 1 – Trust Rating



Applicant 59-Q Applicant 68-K Applicant 47-S Applicant 24-V

**Applicant 59-Q**  
Project Manager/Consultant at Bing and Jakobson, Inc.

**Education**  
Earlbed University, 1996  
Bachelor of Arts: Business Finance  
"Is kind and caring toward others. Goes well above and beyond the call of duty to look out for other students' best interests." - Professor of Business Finance

**Experience**  
Bing and Jakobson, Inc., 2003 - Present  
**Project Manager / Consultant**  
Responsibilities: Developed formal presentations for potential customers, the delivery of a final product to customers under strict deadlines, and development of team building exercises.  
"Puts forth an extra effort to support others. Takes good care of the employees." - Executive Supervisor  
Creations 4 Us, 1996 - 2003  
**Human Services Manager**  
Responsibilities: Organization and development of training programs for customer care relations

**Volunteer Experience and Personal Interests**  
Community Dancing Club, 1999 - Present  
**Member**  
Assisted in the organization and planning of dancing lessons and events.  
"Bends over backwards to help you out whenever possible. Has always been particularly good to me." - Co-Club Member

**ABI Manipulations (benevolence)**

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
The applicant would be very capable of performing his/her job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The applicant would be successful at the things he/she tries to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The applicant would have knowledge about the work that needs done.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel very confident about the applicant's skills.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Next



# Task 2 – Job Selection



Benevolence

Integrity

Drag and Drop the applicant to a position.

Please select the level of confidence you have in your decision.

Your Supervisor:

Drop Applicant Here

Unselected

Co-Worker:

Drop Applicant Here

Unselected

Other's Supervisor:

Drop Applicant Here

Unselected

Continue

Ability

Neutral

Fill Positions	Rank Applicants
<p><b>Applicant 59-Q</b></p> <p>"Is kind and caring toward others. Goes well above and beyond the call of duty to look out for other students' best interests.", <b>Professor of Business Finance</b></p> <p>"Puts forth an extra effort to support others. Takes good care of the employees.", <b>Executive Supervisor</b></p> <p>"Bends over backwards to help you out whenever possible. Has always been particularly good to me.", <b>Co-Club Member</b></p>	<p><b>Applicant 68-K</b></p> <p>"Acts on the up and up from what I've seen and heard. Always fair and honest.", <b>Professor of Business Finance</b></p> <p>"Has a strong moral foundation. Always does the right thing even in morally difficult situations.", <b>Executive Supervisor</b></p> <p>"Is honest, just, and impartial without fail.", <b>Co-Club Member</b></p>
<p><b>Applicant 47-S</b></p> <p>"Consistently demonstrated strong skills on class projects and understanding of course material.", <b>Professor of Management</b></p> <p>"A good employee who's technical know-how is widely regarded as state-of-the-art.", <b>Executive Supervisor</b></p> <p>"Proficient and competent while completing work. Performs quality work. Always gets things done well.", <b>Co-Club Member</b></p>	<p><b>Applicant 24-V</b></p> <p>"Judgment is not always ethically sound.", <b>Professor of Business</b></p> <p>"Does not have a strong set of principles. Lacks a moral center.", <b>Executive Supervisor</b></p> <p>"We have known each other for about two years.", <b>Co-Club Member</b></p>





# Task 3 – Ranking



Fill Positions	Rank Applicants
<p><b>Applicant 59-Q</b></p> <p>"Is kind and caring toward others. Goes well above and beyond the call of duty to look out for other students' best interests.", <b>Professor of Business Finance</b></p> <p>"Puts forth an extra effort to support others. Takes good care of the employees.", <b>Executive Supervisor</b></p> <p>"Bends over backwards to help you out whenever possible. Has always been particularly good to me.", <b>Co-Club Member</b></p>	<p><b>Applicant 68-K</b></p> <p>"Acts on the up and up from what I've seen and heard. Always fair and honest.", <b>Professor of Business Finance</b></p> <p>"Has a strong moral foundation. Always does the right thing even in morally difficult situations.", <b>Executive Supervisor</b></p> <p>"Is honest, just, and impartial without fail.", <b>Co-Club Member</b></p>
<p><b>Applicant 47-S</b></p> <p>"Consistently demonstrated strong skills on class projects and understanding of course material.", <b>Professor of Management</b></p> <p>"A good employee who's technical know-how is widely regarded as state-of-the-art.", <b>Executive Supervisor</b></p> <p>"Proficient and competent while completing work. Performs quality work. Always gets things done well.", <b>Co-Club Member</b></p>	<p><b>Applicant 24-V</b></p> <p>"Judgment is not always ethically sound.", <b>Professor of Business</b></p> <p>"Does not have a strong set of principles. Lacks a moral center.", <b>Executive Supervisor</b></p> <p>"We have known each other for about two years.", <b>Co-Club Member</b></p>

**Please rank all applicant from best (1) to worst (4) choice for each position.**

**Your Supervisor:**

- (1) Drop Applicant Here
- (2) Drop Applicant Here
- (3) Drop Applicant Here
- (4) Drop Applicant Here

Continue



# High CL



Applicant 59-Q   Applicant 68-K   Applicant 47-S   Applicant 24-V

**Applicant 59-Q**  
Project Manager/Consultant at Bing and Jakobson, Inc.

**Education**  
Earlbed University, 1996  
Bachelor of Arts: Business Finance  
"Is kind and caring toward others. Goes well above and beyond the call of duty to look out for other students' best interests." - Professor of Business Finance

**Experience**  
Bing and Jakobson, Inc., 2003 - Present  
**Project Manager / Consultant**  
Responsibilities: Developed formal presentations for potential customers, the delivery of a final product to customers under strict deadlines, and development of team building exercises.  
"Puts forth an extra effort to support others. Takes good care of the employees." - Executive Supervisor  
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Responsibilities: Organized customer care relations

**Volunteer Experience and Personal Interests**  
Community Dancing Club, 1999 - Present  
**Member**  
Assisted in the organization and planning of dancing lessons and events.  
"Bends over backwards to help you out whenever possible. Has always been particularly good to me"

	Strongly Disagree	Disagree	Somewhat Disagree	Neither or Dis	Strongly Agree
The applicant would be very capable of performing his/her job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The applicant would be successful at the things he/she tries to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The applicant would have knowledge about the work that needs done.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel very confident about the applicant's skills.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Next

**Task List** X

Applicant	Priority
Applicant 96-R	MED
Applicant 48-E	HIGH

Applicant 54-C (LOW) for Resume Validator

Add



# Preliminary Results Job Selection



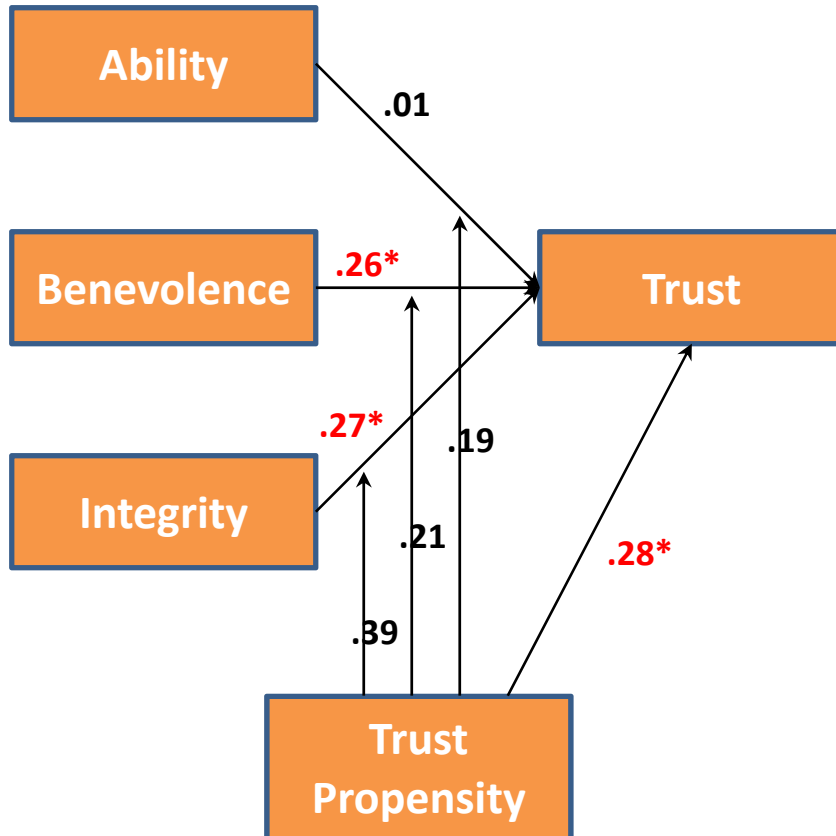
- **CL manipulation successful**
  - High *M*: 3.625, Low *M*: 3.037;  $t(72)=5.201$ ,  $p<.001$
- **ABI indicators predicting Position Selection**
  - **Appears ABI model only predictive under low CL**

LowCL Condition		% of time selected for position of ..		
Applicant	Supervisor	Other's Supervisor	Co-Worker	
HiAbility		0.250	0.175	0.575
HiBenev		0.513	0.238	0.250
HiIntegrity		0.238	0.575	0.175
Neutral		0.000	0.013	0.000
	Total	1.000	1.000	1.000

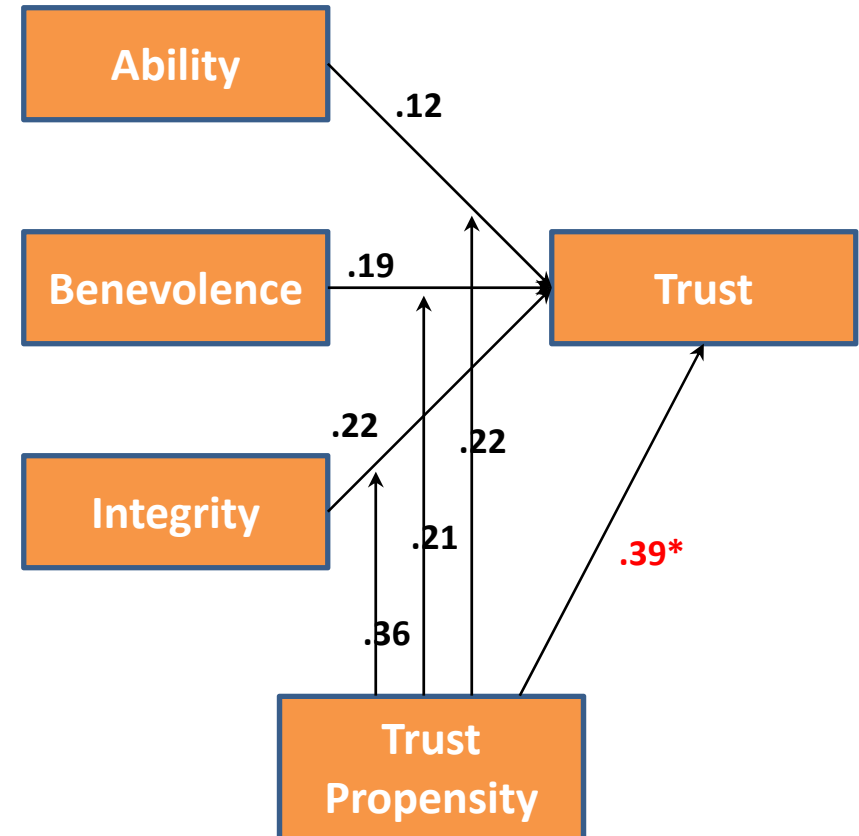
HiCL Condition		% of time selected for position of ..		
Applicant	Supervisor	Other's Supervisor	Co-Worker	
HiAbility		0.250	0.275	0.450
HiBenev		0.350	0.325	0.313
HiIntegrity		0.400	0.388	0.200
Neutral		0.000	0.013	0.038
	Total	1.000	1.000	1.000



Low CL



High CL







# Preliminary Interpretation



- **ABI model did not hold under high CL conditions for personal relevance**
  - Trust judgments based more on Trustor attributes and heuristic processing
  - Rational models of cognition and judgment (such as ABI model) fail to capture complex and dynamic nature of human choice and behavior in “the real world” where cognitive demands are high (Kahneman, 2003; Klein, 1993)
  - Kahneman distinguishes b/w :
    - Intuitive reasoning – rapid, automatic, affect-laden **(used for High CL)**
    - Objective reasoning – slow, effortful, evaluative **(used for Low CL)**



# Preliminary Interpretation Continued.....



- **Next Steps w/ remaining data collection:**
  - Refine current analyses as needed and conduct primary hypothesis tests
  - Examine state affect and personality effects on trust judgments and position selection
  - Examine if cognitive effects hold in other cultures
  - Compare position selections based on ABI in other cultures
  - Ability approached significance under high CL; will another ABI indicator be significant (or close) in a collectivist culture?



# Dynamic Model of Trust



## 1. Effects of CL

Grant AOARD-11-4056

Charlene Stokes, Joseph Lyons, Kevin Eschelman, Johanna Culbertson

US AFRL, Dayton

Mei Hua Lin

The screenshot shows a resume validation interface for 'Applicant 35-U', a Project Manager at Distal, Inc. The interface is divided into sections: Education, Experience, and Volunteer Experience and Personal Interests. Below these sections is a table for validation with columns for 'Strongly Disagree', 'Disagree', 'Somewhat Disagree', 'Neither Agree or Disagree', 'Somewhat Agree', 'Agree', and 'Strongly Agree'. The table contains four rows of statements with corresponding radio buttons for selection. A 'Next' button is at the bottom left, and a green box at the bottom right indicates 'Applicant 35-U (MEDI) for Resume Validator'.

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
The applicant would be very capable of performing his/her job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
The applicant would be successful at the things he/she likes to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
The applicant would have knowledge about the work that needs done.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>
I feel very confident about the applicant's skills.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>

Next

Applicant 35-U (MEDI) for Resume Validator



# Dynamic Trust Model Project – Overall Objectives

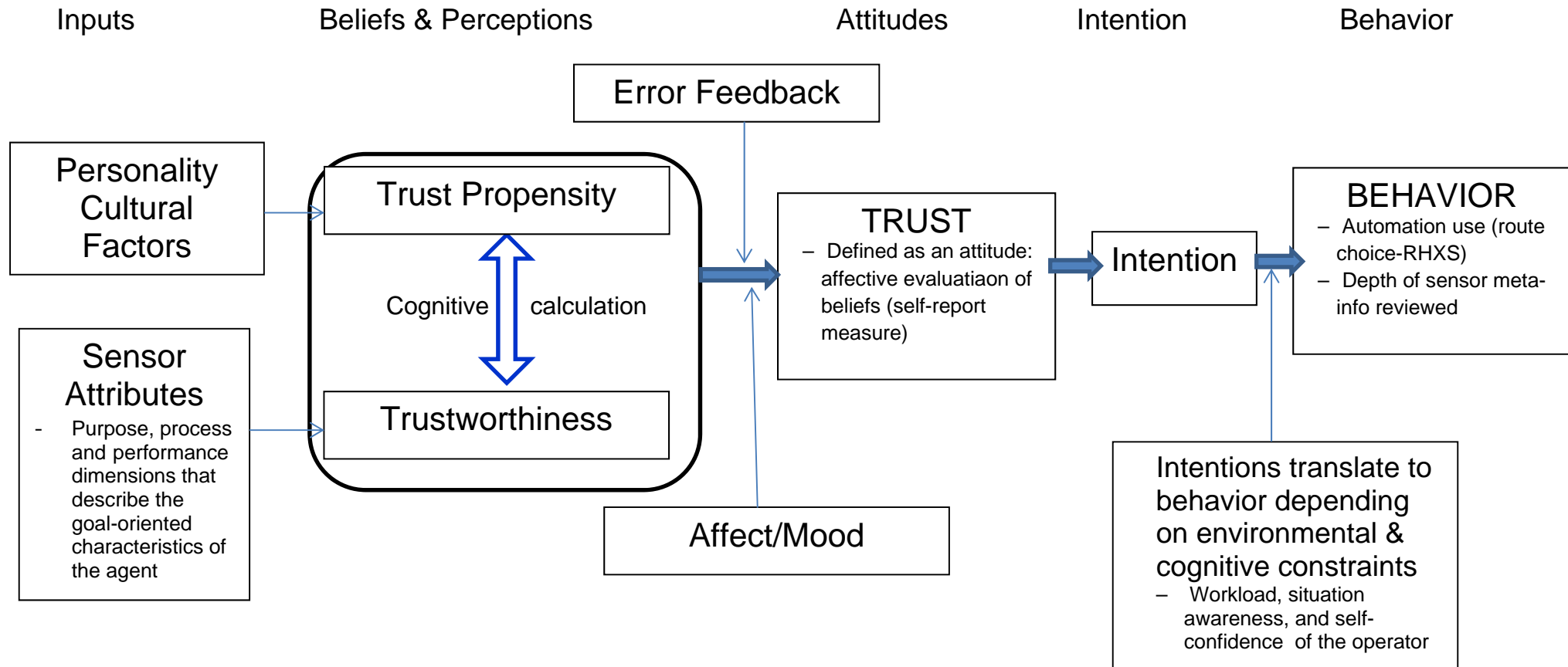


- **Explore the relative impact of the trustworthiness indicators in the dynamic trust model [Mayer, 1995]**
- **Three factors in the dynamic trust model:**
  - Ability (competence), Benevolence (goodness) and Integrity (reliability/predictability)
- **Strength/contribution of each aspect of the trust judgment may vary:**
  - By the type of activity being performed e.g. depending on the role the trustee is to take (friend, nanny, or boss)
  - CL in context – how mentally demanding the other tasks are while you are making the judgment
  - By culture e.g. individualistic vs. collectivistic cultural influences – competence vs. benevolence



# Conceptual Model of Trust

[Lee & See, 2002; Colquitt et al., 2007; with additions by Stokes, 2010]





# Trust and CL



- Trust is “willingness of an individual to accept vulnerabilities from others” [Mayer95]
- CL is “a multidimensional construct that represents the load that performing a particular task imposes on the cognitive system” [Paas94].
- Central to the importance of CL is the working memory.
- Working memory is defined as a “*limited capacity* system, which *temporarily stores* information, and *supports* human thought processes by providing an interface between perception, long-term memory and action” [Baddelley2003].
- Increased CL leads to overload of the working memory resources [Baddelley2001] and change in the established cognitive behaviour [Oviatt2004]



# Hypotheses and Expected Outcomes



- **Cognitive processes are involved in cognitive trust and affective trust**
- **CL manipulations are likely to affect the thought process**
- **CL manipulations are more likely to affect/disrupt cognitive trust**
  - e.g. gauging the suitability of a job candidate for the manager role or as a colleague
- **Load manipulations are less likely to affect judgement whether a person is trustworthy enough to be a friend**
- **Expect to find greatest difference in experienced CL in decisions involving manager/colleague than friend \***
- **Cultural factors can affect the interdependence of CL and trust, such that cultural biases in trust will be exacerbated under high CL.**





# User Study Design and Testing Tool



- **HR Applicant Screening Tool**
  - Developed in-house, cross-platform custom application that incorporates all data collection, Dual versions (high CL and low CL)
  - Several design, story boarding, wireframe iterations

Applicant 68-K   Applicant 59-Q   Applicant 24-V   Applicant 47-S

**Applicant 68-K**  
 Manager at Diaw Lighting and Configuration, Inc.

**Experience**  
 Diaw Lighting and Configuration, Inc., 2001 - Present  
*Project Manager / Consultant*  
 • Responsibilities: Job duties involved leading a team of sales associates and developing team cohesiveness.  
 "Has a strong moral foundation. Always does the right thing even in morally difficult situations." - Executive Supervisor  
 Boris, Blackwood, & Harris, Inc., 1995 - 2001  
*Human Services Manager*  
 • Responsibilities: Organization and development of product development

**Education**  
 Jackson University of Liberal Arts, 1995  
 Bachelor of Arts: Business  
 "Acts on the up and up from what I've seen and heard. Always fair and honest." - Professor of Business Finance

**Volunteer Experience and Personal Interests**  
 Weekend Readers Book Club, 2001 - Present  
*Member*  
 • Assisted in the organization and planning of book discussions for club members.  
 "Is honest, just, and impartial without fail." - Co-Club Member

	Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Agree	Strongly Agree
The applicant would be very capable of performing his/her job.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The applicant would be successful at the things he/she tries to do.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The applicant would have knowledge about the work that needs done.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel very confident about the applicant's skills.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Next





# User Study Design and Data



- **Study Design**
  - **Tasks:** Rating, Positioning, and Ranking job applicants
  - **CL** (High vs Low): dual task (queuing job applicants)
  - Manipulation of **trustee**: my manager, my colleague, others' manager
  - Manipulation of **trust** factors: ability, benevolence, integrity
  - Cultural: Malaysian, Australian, American (collectivistic, individualistic)
- **Behavioural Measures**
  - Speech: think-aloud protocol was used for CLM
  - Interactive Behaviour:
    - mouse trajectories, selection, typing, browsing activity (attentional focus)



# User Study Design and Data Continued...



- **Performance Measures**
  - Time-to-completion; time to response; amount of speech
  - Performance on secondary task (queuing incoming applicants)
  - Trust ratings for different positions/roles
  - Rank ordering of the applicants into three categories/roles
- **Self Report Measures**
  - Subjective ratings of mental effort (Lickert scales)
  - Trust propensity



# Project Progress Overview



- - **Internal Review Board (IRB) Approvals**
    - All sites were approved.
  - **Pilots**
    - Pre-pilot material and experiment tool design completed
    - Pilot experiments were conducted in **mid-2011**
    - Content/manipulations were tested for bias using Survey Monkey.
    - A student group from University of New South Wales (Australia) (UNSW) (30) participated
  - **Wright-Patterson team visited Sydney late August 2011**
    - Trial runs, pilots and think-aloud tests, final interface designs
    - Planning for data collection, analyses and next stage proposal.
  - **Study/Participants**
    - Australian group: 90 students from the University of Sydney participated in the user study in **November 2011**
    - Malaysian group: 130 students from Sunway University participated in the user study in **July 2012**
    - US group: data collection in progress



# Data Collection and Analysis Summary



- **Australian data collection brief stats:**

- 90 subjects completed both conditions (high and low CL)
- 239 survey/response data points per subject
- Speech data: 6.5Gb = 58 hours of speech
- Interactive Behaviour: ~96 million data points
  - including mouse trajectories, selection, typing, browsing activity (attentional focus)
- Speech transcriptions: ~80,000 words from effective speech



# Data Collection and Analysis Summary Continued....



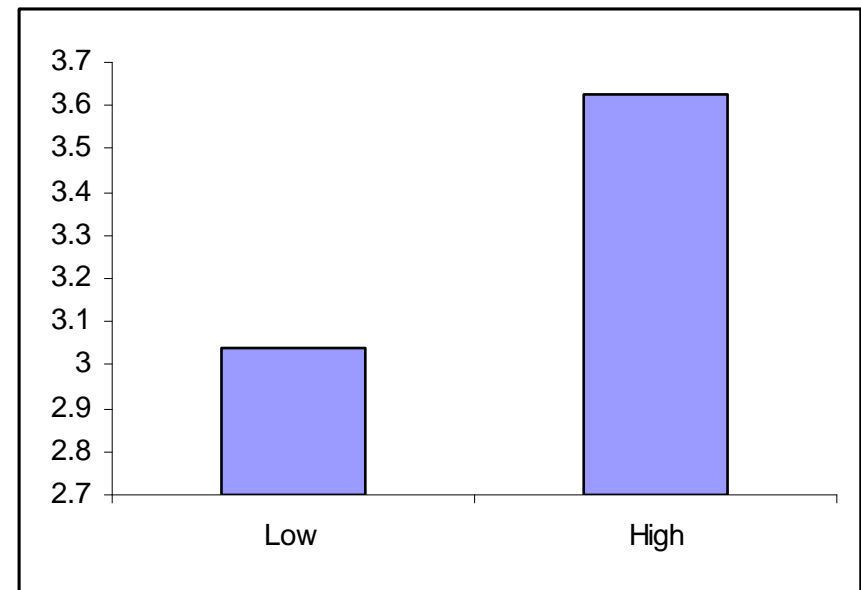
- **Analysis of Data from Australian site:**
  - Subjective Analysis of CL
  - Performance Analysis
    - Completion times
    - Response times
    - Amount of speech (proportional speech, word count, words per sentence)
    - Dual-task performance
  - Behavioural Analysis
    - Linguistic data
    - Speech data
    - Mouse and interaction behaviour



# Analysis Summary



- **Analysis of Data from Australian site:**
  - **Subjective Analysis** of CL (to validate the experiment design)
  - Collected at the end of both the high load and low load task sessions
  - Based on a 7-point Likert scale (1=“Extremely easy” and 7=“Extremely difficult”).
  - Mean ratings:
    - Low load: 3.037
    - High load: 3.625
    - ( $t(72)=5.201, p<.001$ )

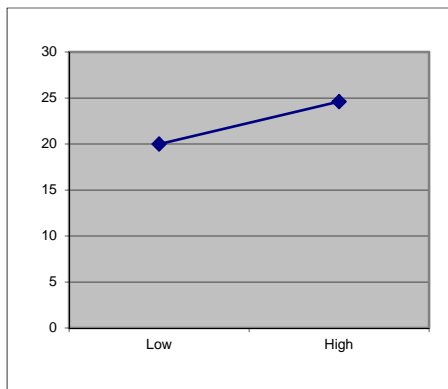




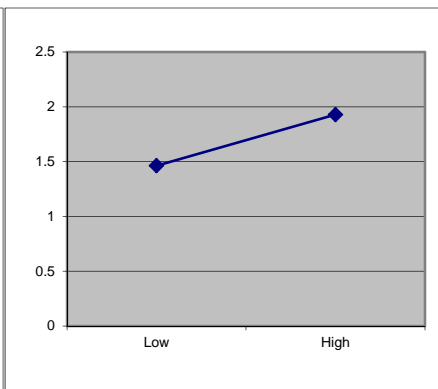
# Analysis Summary Continued.....



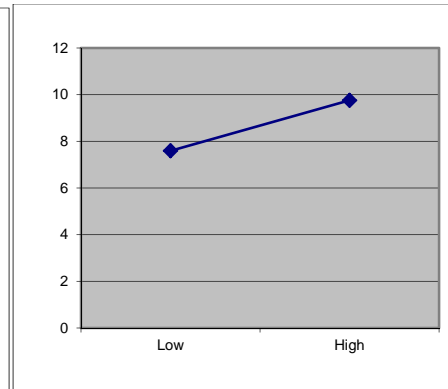
- **Analysis of Data from Australian site:**
  - Performance Analysis
    - **Completion times and Response times**
    - On average, participants spent more time on high CL task than low CL task
    - On average, their response latency was higher under high CL task
    - Effective speech amount
      - Proportional speech – *no difference* under low and high CL ( $p=0.2$ )
      - Average word count – *no difference* ( $p=0.1$ ) (confirming above)
      - Average # words per sentence – longer sentences under high CL task



Avg task completion time (min.)  
 $p<0.02$



Avg Response Time (sec.)  
 $p<0.002$



Avg # words per sentence  
 $p<0.001$



# Analysis Summary Continued.....



- **Analysis of Data from Australian site:**
  - Behavioural Analysis
    - Linguistic Analysis of Speech Data
      - Over 70 participants' speech being transcribed and annotated
      - Preliminary analysis results based on 55 subjects
  - Pause Analysis
  - Linguistic Category Analysis





# Analysis Summary Continued.....

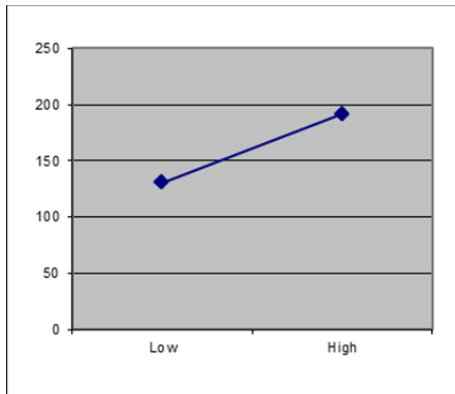


- **Analysis of Data from Australian site:**

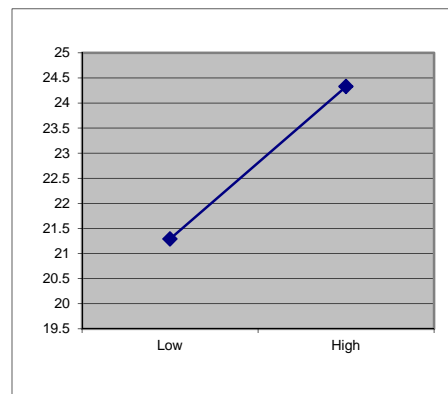
- Behavioural Analysis

- **Pause Analysis**

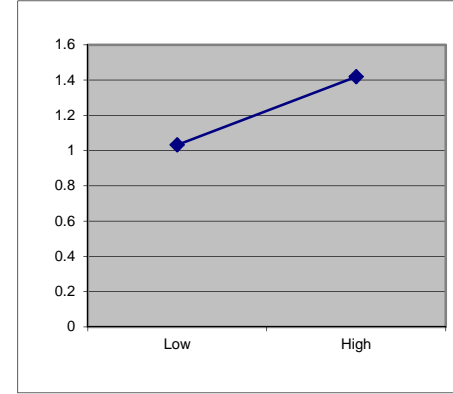
- On average, participants paused more under high CL task
      - On average, they also paused longer under high CL task than low CL task



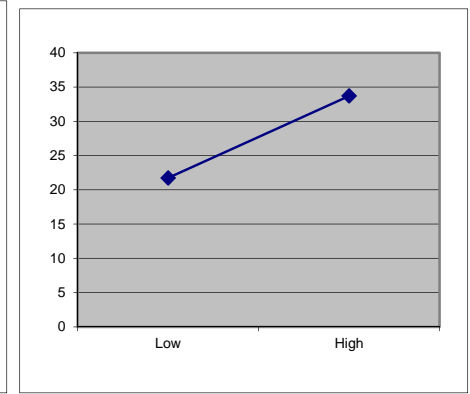
Avg # of total pauses  
 $p < 0.01$



Avg # of pauses (min)  
 $p < 0.01$



Avg Length of Pauses  
 $p < 0.0001$



% of Time Pausing  
 $p < 0.0001$



# Analysis Summary Continued.....

- **Analysis of Data from Australian site:**
  - Behavioural Analysis
    - **Linguistic Category Analysis** (based on Linguistic Inquiry and Word Count (LIWC) dictionary)

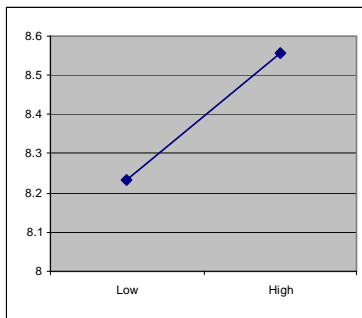
Linguistic Categories	Example words
Personal pronouns	I, they, her, we
Impersonal pronouns	it, those, it's, that
Adverbs	very, really, quickly, mostly
Negations	no, not, never, neither
Quantifiers	few, many, much, fairly
Swear words	damn, shit, fuck, piss
Affective (emotional) processes	happy, cry, glad, afraid
Positive emotions	nice, sweet, cool
Negative emotions	ugly, nasty, bad, fail, sorry
Anxiety	worried, fearful, nervous
Anger	hate, kill, annoyed
Sadness	sad, grief, cry
Cognitive processes	know, cause, opinion
Insight	think, know, consider
Causation	hence, effect, because
Discrepancy	should, would, could
Tentative	maybe, perhaps, guess
Certainty	always, never, absolutely
Achievement	win, hero, ability, perform
Assent	agree, ok, yes, cool
Trust	trust, believe, sure
Distrust	doubt, disbelieve, suspicious



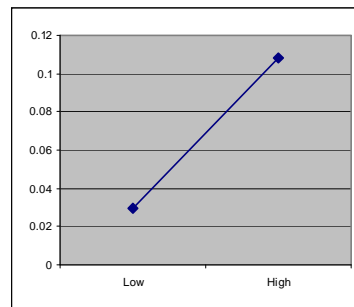
# Analysis Summary Continued.....



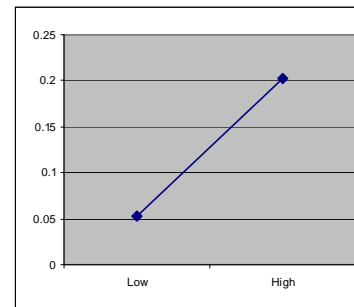
- **Analysis of Data from Australian site:**
  - Behavioural Analysis
    - **Linguistic Category Analysis** (based on LIWC dictionary)



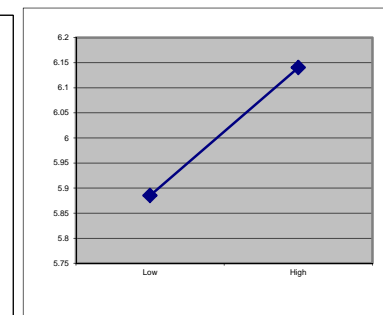
% of Negative Emotion Words



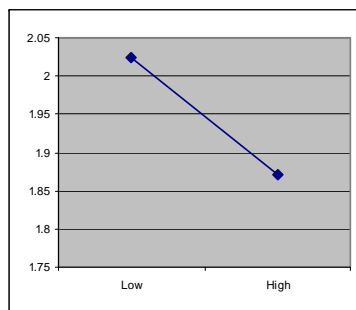
% of Swear Words



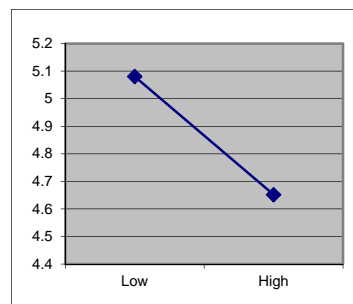
% of Anger Words



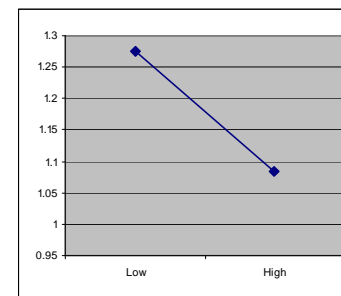
% of Tentative Words



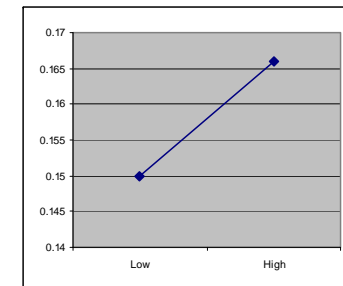
% of Certainty Words



% of Achievement Words



% of Trust Words



% of Distrust Words



# Analysis Summary Continued.....



- **Analysis of Data from Australian site:**
  - Behavioural Analysis
    - **Signal Analysis** of Speech data
      - Data cleaning (e.g. remove cross-talk, segmentation) completed
      - Initial CL Models were built
      - Initial analysis completed
      - Automatic classification of CL levels showed **63% performance**
      - Currently working to improve the results.
    - **Mouse and interaction behaviour analysis**
      - Mouse interaction data cleaning completed
      - Mouse interaction features identified for analysis
      - Currently in the process of developing Machine Learning (ML) method to classify CL



# Next Tasks



- **Finalize Linguistic analysis**
- **Speech analysis – refine CL models**
- **Interaction analysis**
  - ML method to be refined to analyse mouse interaction data
  - Selection and Typing data analysis
- **Performance analysis**
  - Analysis of rating/ranking performance
  - Dual-task performance
- **Relationship between CL and individual Trustworthiness (ABI) judgements**
- **Intercultural analysis**
  - Comparison of data collected from all three sites (USA, Malaysia, Australia)
- **Consolidating findings from the three sites**
- **Write-up of findings**
- **Publication of findings**
- **Final Year Report**



**QUESTIONS?**

**CONTACT:**  
**CHARLENE.STOKES@WPAFB.AF.MIL**

## **LIST OF ACRONYMS**

ABI	Ability Benevolence, Integrity
AFRL	Air Force Research Laboratory
AOARD	Asian Office of Aerospace Research and Development
CI	Cognitive Load
IRB	Internal Review Board
LIWC	Linguistic Inquiry and Word Count
ML	Machine Learning
NICTA	National Information and Communications Technology Australia
PI	Principal Investigator
UNSW	University of New South Wales